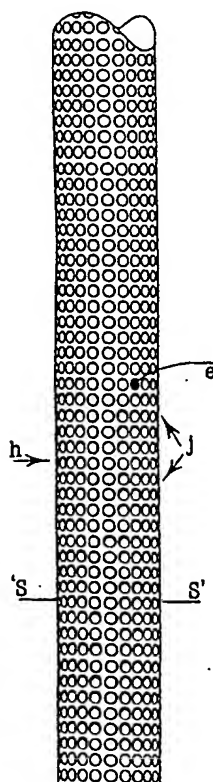


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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁵ : F15D 1/10, B63B 15/00</p>	<p>A1</p>	<p>(11) International Publication Number: WO 94/02744 (43) International Publication Date: 3 February 1994 (03.02.94)</p>
<p>(21) International Application Number: PCT/CA92/00310 (22) International Filing Date: 16 July 1992 (16.07.92) (71)(72) Applicant and Inventor: VELKE, Willi, H. [CA/CA]; P.O. Box 154, 277 Campbellville Road, Campbellville, Ontario L0P 1B0 (CA). (81) Designated States: JP, RU, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LU, MC, NL, SE). Published <i>With international search report.</i></p>		
<p>(54) Title: A DEVICE TO REDUCE DRAG OVER THE SURFACE OF MAST AND BOOM OF A SAILCRAFT</p> <p>(57) Abstract</p> <p>A device which improves fluid flow across the surface of mast and boom of a sailcraft, by including in the surface of such mast and boom, a pattern of discrete surface depressions (e), resulting in the decrease of base drag and the increase of efficiency of the sail arrangement.</p>  <p>The diagram shows a vertical, elongated rectangular structure representing a mast or boom. The entire surface of this structure is covered with a dense, regular grid of small circles, each labeled with the letter 'e'. These circles represent discrete surface depressions. On the left side of the structure, a horizontal arrow labeled 'h' points towards the surface, indicating the direction of fluid flow. On the right side, there are two vertical arrows labeled 'j' pointing downwards, likely representing a secondary flow or a specific measurement. At the bottom of the structure, there are two horizontal lines labeled 's' and 's''.</p>		

**A DEVICE TO REDUCE DRAG
OVER THE SURFACE OF MAST AND BOOM OF A SAILCRAFT**

BACKGROUND OF THE INVENTION.

5 This invention relates to a mast, and more particularly to a mast of a sailboat, which is equipped with the means to reduce drag across its surface.

 The mast of a sailboat together with the boom, which is attached to the mast, provides the necessary structure
10 to hold in place the sail which catches the wind and converts its force into the forward motion of the sailboat.

 The amount of forward velocity a sailboat may achieve, depends to a large degree on the strength of the wind and the efficiency of the sail arrangement. Air flow over the
15 sail is affected by the turbulent wake created by the surface of the mast, resulting in a base drag condition which greatly reduces the efficiency of the sail.

 Furthermore, the combination of wake or low pressure on one side of the mast and the corresponding high pressure on the
20 opposite thereof, creates a weight condition which greatly influences the effect of gravity on the mast, which needs to be calculated into the design and construction of a sailboat, especially with respect to the keel.

 It is a general rule, that a pound of weight or
25 pressure on a mast at a height of 32 feet from the centre of gravity of a boat needs to be countered by at least 30 pounds of weight below the centre of gravity at the keel, in order to maintain proper balance.

 As the weight of the keel is considered "dead weight",
30 any reduction of it would be directly expressed in increased boat performance.

 It is therefore most desirous to have available a means to reduce the amount of base drag occurring behind mast and boom of a sailboat, thereby increasing its sail
35 efficiency.

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35 efficiency.

SUMMARY OF THE INVENTION

Although one aspect of the present invention relates to a mast and boom application for a sailboat, the scope of the present invention generally embraces all continuous
5 single curvature elongated bodies, such as tubes, rods, cables, wires and the like, which are located adjacent a fluid in relative motion and thereby experiencing significant amounts of base drag.

In accordance with the present invention, a single
10 curvature elongated body includes in its surface a pattern of surface discontinuities arranged along at least a portion of the surface of such elongated body. Preferably, the surface discontinuities include discrete, generally spheroidal, concave sub-surfaces extending below the
15 surface of such elongated body. Regular, discretely shaped surface discontinuities have the advantage of dealing uniformly with changing flow patterns and are independent of the angle of attack the flow takes across the surface of such single curvature elongated bodies.

20 As already mentioned, the present invention has a broad range of application, and covers a variation of continuous single curvature elongated bodies. In accordance with one aspect of the invention, for example, the surface is moving and the fluid is generally
25 stationary. Examples of this aspect of the invention includes exterior surfaces of tubular struts and bracings of landing gears and fixed wheel arrangements on small aircraft and on helicopters and the like.

In the case of a mast and boom of a sailboat, both the
30 surface and the fluid are in motion.

In another aspect of the invention only the movement of the fluid provides the relative motion between the exterior surface and the fluid. Applications of this type include exterior surfaces of tubular shapes used in the
35 construction of ocean drill platforms, especially for below

the waterline. Further examples include exterior surfaces of parts of high towers and bridges and the like, using tubular shapes in their construction.

In general, fluid passing across a smooth exterior
5 surface of a single curvature elongated body, such as a tube, rod or wire, produces turbulent flow creating a low pressure or base drag condition behind such body.

The present invention therefore, assists in changing fluid flow behaviour across elongated bodies, such as
10 tubes, rods, wires and the like, thereby significantly reducing the low pressure area or the resulting base drag and increasing overall efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

15 **Figure 1** of the drawings depicts a preferred embodiment of the present invention, comprising a portion of a sail arrangement, including part of a mast and boom.

Figure 2 of the drawings depicts a section view through the mast or boom, indicated as 'S-S' in Figure 1.

20 **Figure 3** of the drawings depicts a section view through the mast or boom, indicated as 'S-S' in Figure 1 showing an alternative arrangement.

Figure 4 of the drawings depicts a portion of a tube or wire, indicating the direction of relative fluid motion
25 and the location of the corresponding low pressure area.

Figure 5 of the drawings depicts a section view through the tube at 'S-S', as indicated in Figure 4.

Figure 6 of the drawings depicts an alternate section view through the tube at 'S-S' as indicated in Figure 4.

30 **Figure 7** of the drawings depicts a variety of exterior surface discontinuities.

DETAILED DESCRIPTION OF THE DRAWINGS

For the purpose of understanding the principle of the
35 present invention, reference will now be made to the embodiment illustrated in the drawings, and specific

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language will be used to describe the same. It will nevertheless be understood that no limitations of the scope of the invention is hereby intended, such alterations and further modifications in the illustrated device, and such
5 further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Figure 1 of the drawings shows an elevated view of a
10 portion of a sail (a), including a portion of the mast (b) and the boom (c). Both boom and mast include in their surface a pattern of surface discontinuities (e), designed to affect fluid flow behaviour across such surface areas.

Figure 2 of the drawings depicts a view through
15 section line 'S-S', through mast or boom, as indicated in Figure 1 of the drawings. This view illustrates the surface discontinuities (e) as depressions in the surface (d) of such mast or boom.

Figure 3 of the drawings depicts a view through
20 section line 'S-S', through mast or boom, as indicated in Figure 1 of the drawings, but this time illustrating the surface discontinuities (e) as protrusions in the surface (d) of such mast or boom.

Figure 4 of the drawings depicts a more general shape
25 of a portion of a continuous curvature elongated body, such as a tube, rod or wire, with its surface equipped with a pattern of surface discontinuities (e), and illustrating the direction of relative fluid motion over its surface with arrow (h) and the location of the low pressure area
30 opposite as indicated by arrows (j).

Figure 5 of the drawings depicts a section through
section line 'S-S', as indicated in Figure 4, showing an
alternative oval shaped circumference of such tube, rod or
wire, and including in its surface (d) a pattern of surface
35 discontinuities (e).

5

Figure 6 of the drawings shows again another alternative to the shape of the circumference of such tube, rod or wire, as indicated in Figure 4, this time illustrating an uneven shape, and including in its surface
5 (d) a pattern of surface discontinuities (e).

Figure 7 of the drawings depicts a variety of shapes of surface discontinuities, as viewed through section line 'S-S' as indicated in Figure 4 of the drawings. The discontinuities illustrated here show a selection of
10 possible depressions (b), (d), (i), (j) and (k), and protrusions (l) and (m), demonstrating some of the varieties of surface discontinuities able to affect fluid flow behaviour over the surface of a continuous single curvature elongated body.

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I claim:

1. A device which improves fluid flow behaviour over the surface of a continuous, single curvature elongated body, such as a tube, rod or wire, positioned adjacent a fluid,
5 moving relative thereto, with such device consisting of a pattern of surface discontinuities, arranged over at least a portion of the surface of the elongated body, thereby forming a distinct pattern of designed surface and sub-surface regions with certain sheering qualities, effective
10 in reducing, without inducing off-setting surface friction, low pressure and base drag normally existing behind such elongated body, opposite the direction of relative fluid motion.
2. A tube, rod or wire according to claim 1, which is of
15 a predetermined length.
3. A tube, rod or wire according to claim 1, wherein the circumference of such tube, rod or wire is round.
4. A tube, rod or wire according to claim 1, wherein the circumference of such tube, rod or wire is oval.
- 20 5. A tube, rod or wire according to claim 1, wherein the circumference of such tube, rod or wire is of uneven shape.
6. A tube, rod or wire according to claim 2, wherein the length of such tube, rod or wire is of a tapered configuration.
- 25 7. A surface according to claim 1, wherein said surface discontinuities consist of discrete depressions, extending below the surface, creating a sub-surface region with certain sheering qualities.
8. A surface according to claim 1, wherein said surface
30 discontinuities consist of protrusions, extending above the surface, creating a sub-surface region with certain sheering qualities.
9. A surface according to claim 7, wherein said depressions are trough-like, and arranged in a generally
35 90° angle to the expected direction of fluid flow.

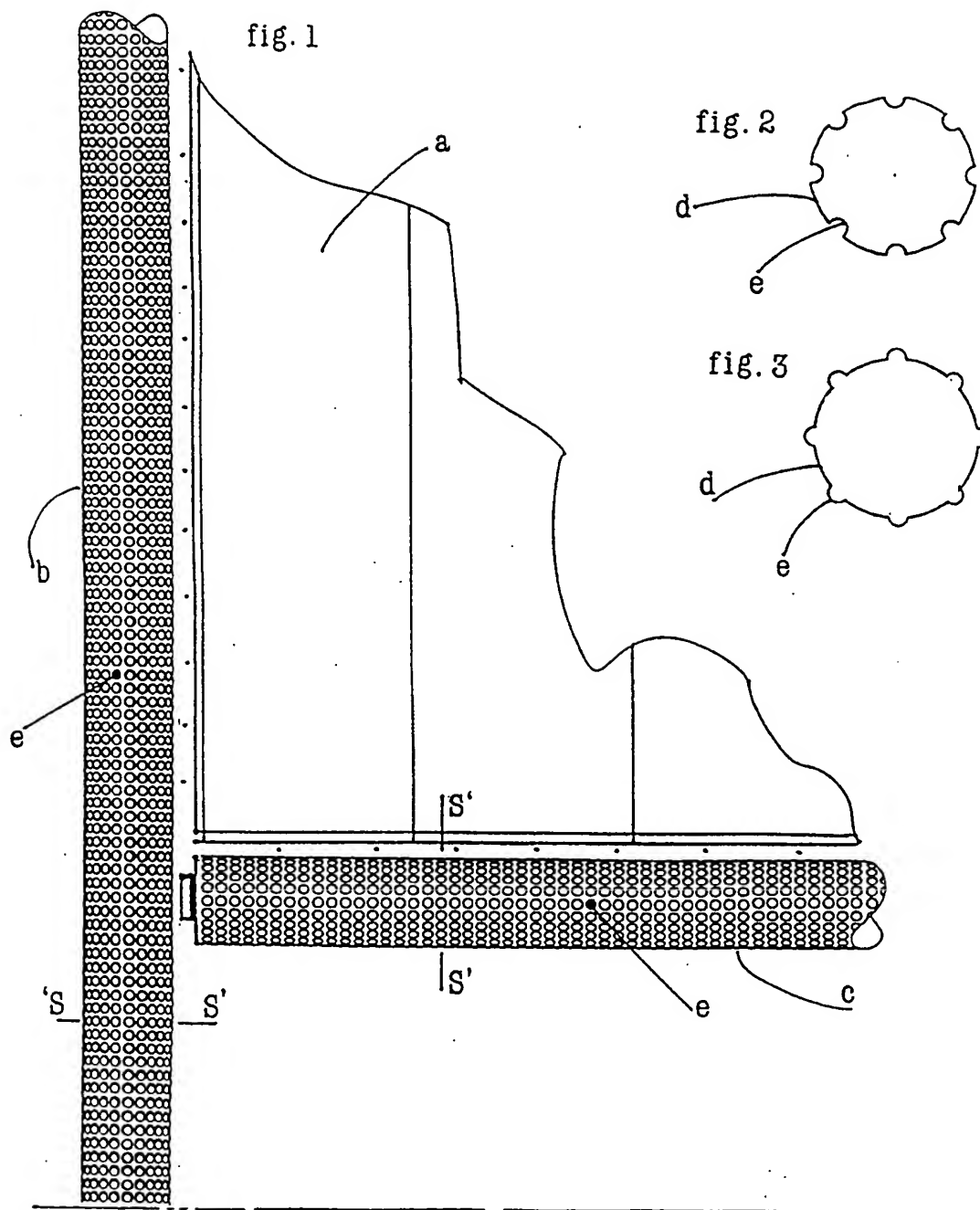
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10. A surface according to claim 8, wherein said protrusions are ridge-like, and arranged in a generally 90° angle to the expected direction of fluid flow.

11. A surface according to claim 8, wherein said
5 protrusions are inter-connected or in communication with each other.

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fig. 4

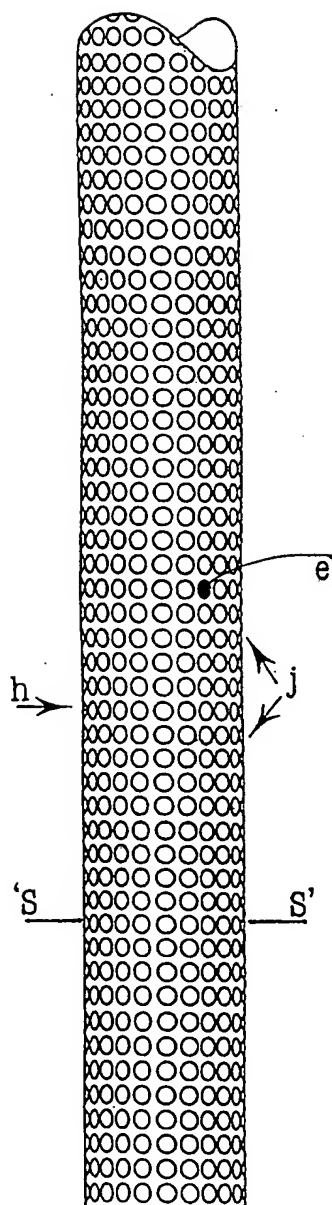


fig. 5

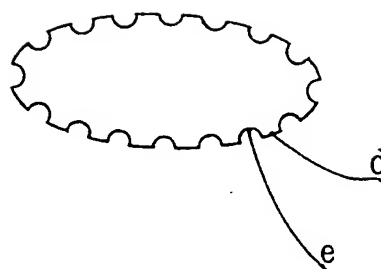


fig. 6

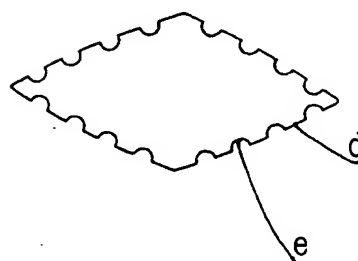
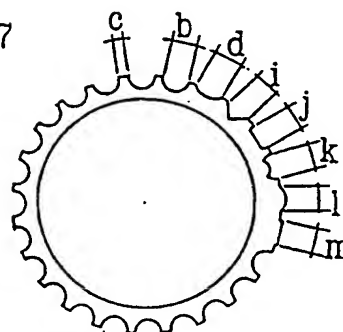


fig. 7



INTERNATIONAL SEARCH REPORT

PCT/CA 92/00310

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 F15D1/10; B63B15/00		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
Int.Cl. 5	F15D ; B63B	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	GB,A,1 440 330 (COUCH) 23 June 1976 see page 1, line 15 - line 25 see page 1, line 51 - line 79; figures ---	1,2,4,8
X	WO,A,9 101 247 (VELKE) 7 February 1991 see claims; figures ---	1,7,9
X	GB,A,730 121 (GRAY) 18 May 1955 see claims; figures ---	1,4
X	FR,A,2 301 715 (NEDERLANDSE ORGANISATIE VOOR TOEGEPAST-NATUURWETENSCHAPPELIJK ONDERZ..) 17 September 1976 see claims; figures ---	1,2,3,8
	-/--	
<p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search 22 OCTOBER 1992		Date of Mailing of this International Search Report 1 2. 01. 93
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer DE SCHEPPER H.P.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	DE,A,3 110 513 (STEIN) 7 October 1982 see claims; figures -----	1-4,8

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. CA 9200310
SA 62431**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
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WO-A-9101247	07-02-91	AU-A- 6037390	22-02-91
GB-A-730121		None	
FR-A-2301715	17-09-76	NL-A- 7501866	20-08-76
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		GB-A- 1522213	23-08-78
		JP-A- 51139151	01-12-76
		US-A- 4059129	22-11-77
DE-A-3110513	07-10-82	None	